Monetary policy stance and inflation targeting under financial instability

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Abstract:

In this paper we build and simulate an open macroeconomic model to investigate the dynamic adjustment of domestic output, inflation and real exchange, and the incurred social losses after external shocks. Results are sensitive to the speed of inflation adjustment included in the expectations mechanism of private agents, and to the aggressiveness with which the central bank reacts to inflation. We use those findings to compute the optimal stance of monetary policy, and to uncover the factors that limit the usefulness and applicability of the inflation targeting regime under scenarios of financial instability.

JEL Classification: E1, E3, E4 and E5

Keywords: Inflation targeting, monetary policy rules, inflation expectations, dynamic adjustments.

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1. Introduction.

The on-going global financial crisis has pushed goods and factor markets into long-lasting disequilibria, which endorse important economic and social losses in both industrial countries and emerging market economies. As a result, the need for national authorities to dispose of tractable macroeconomic models for stabilising purposes is pressing. Moreover, the recession triggered by the financial crisis has challenged the capability of central banks, practitioners of inflation targeting strategies, to deal with financial stability and to implement effective monetary policies.

The specialized literature has provided abundant macroeconomic models of high theoretical quality oriented to policy guidance in open economies, most of them in the strand of the New Keynesian open economy approach and including inflation targeting strategies; see, for instance, Clarida, Galí and Gertler (2001), Galí and Monacelli (2005) and Galí (2008). However, the analytical complexity of these models makes them hardly suitable for practical purposes.

Carlin and Soskice (2010) tried to overcome these drawbacks by building a simplified new Keynesian model of an open economy, in which inflation targeting by the central bank and rational expectations in the foreign exchange market play a crucial role. They derived graphically the responses of the central bank and the trajectory of the main variables to a variety of shocks. However, the Carlin and Soskice (2010)'s paper lacks consistency in the assumed expectations mechanism, on the grounds that whereas the foreign exchange market and the central bank exhibit rational expectations, the behaviour of agents of the labour market is guided by a very simple adaptive expectations rule. Moreover, these authors adopt ad hoc assumptions concerning the lags with which the real interest rate impacts on output.

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Levin (2004) built a simple deterministic model to ascertain the impact of two types of external shocks on a number of important economic variables. The assumption of perfect foresight in expectations of both the exchange rate and the rate of inflation makes this work non useful in the present uncertain world. Finally, Neuenkirch and Tillmann (2012) evaluated how central banks respond to inflation deviations from target, but they restrict their analysis to a closed economy.

In this paper we try to overcome these difficulties by building a general equilibrium model for a small open economy, in which behaviour of all agents, including workers and firms, are governed by the same level of rationality. In a first step, we assume that agents have ready and free access to information and that markets work smoothly. Under that scenario, the central bank reacts actively in each period by deciding and applying the level of the interest rate that minimizes the social losses created by a variety of shocks. In a second step, we build a model where both the goods and labour markets suffer imperfections and rigidities that lead to sluggish adjustment in the rate of inflation. In this context, the central bank follows an announced monetary policy rule, and private agents expect the inflation rate to progress gradually towards the inflation target. On the basis of those assumptions and rules, we derive a model for a small open economy composed of three dynamic equations: aggregate demand, aggregate supply and the evolution of the real exchange rate.

In order to verify the dynamic results predicted by our framework, we introduce demand and supply shocks and simulate the model to derive the dynamic responses of the rate of inflation, domestic output and the real exchange rate, and compute the ensuing social losses under alternative assumptions about inflation expectations.

We find that in case of perfect rationality, implementation of the optimal monetary rule avoids any departure of output and inflation from their long-run equilibrium levels, minimizing, by this way, social losses. However, under the less perfect scenario, in which both the central bank and private agents follow empirical rules, the dynamic results crucially depend on two important parameters: the expected speed of inflation adjustment, and the sensitivity with which the central bank reacts to inflation variability. We simulate the model, after different external shocks, and derive the optimal value of each of these parameters for a given value of the other one. It turns out that central banks with inflation targeting strategies are confronted with two alternative ways to minimise social losses: either they clearly announce the (optimal) approximate speed at which they intend to progress to the target in a multi-year plan for a given value of policy stance, or they compute their best response to inflation gaps for a given value of expected speed of inflation adjustment.

Our results also indicate that one way to refine the inflation targeting approach is to include the variability of the interest rate in the loss function, and to assign financial stability as an explicit mandate of central banks.

The paper is organized as follows. Section 2 sets out the model for a small open economy with flexible exchange rate, and derives the long-run equilibrium values and the transition dynamics of each endogenous variable under the assumption that the central bank follows a stable inflation-targeting rule. The solution of the model and the analysis of its dynamic properties are presented in the Appendix to the paper. Section 3 simulates the dynamic adjustments triggered alternatively by a positive permanent demand shock and a transitory supply disturbance, respectively, and computes the ensuing social losses for several values of central bank credibility and sensitiveness to inflation variability. Finally, section 4 summarises the main results

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and derives some policy prescriptions.

2. The open economy model with flexible exchange rate.

In this section, we build and solve a structural general equilibrium model that illustrates the way different external shocks affect the endogenous variables. We extend the simple IS-MP-AS framework for a small open economy with flexible exchange rate.

Monetary authorities are concerned with output and inflation stabilisation, which implies that, after observing the effects of shocks, the central bank modifies the nominal interest rate to minimise social losses. We assume a traditional aggregate supply function in which domestic output departs from its stationary level (potential output) either because inflation is not correctly foreseen, or because external supply shocks hit the economy. The variables of the model are presented in logs except for interest rates and the rate of inflation.

2.1 Rational behaviour and the optimal monetary rule

In a first approach, we assume that both the monetary authorities and the private sector are rational agents that optimise their behaviour. The model is composed of the following equations:

$$L_t = \psi\left(y_t - \acute{y}\right)^2 + \left(\pi_t - \acute{\pi}\right)^2 \quad (1)$$

$$y_t - \acute{y} = -b_i\left(R_t - \acute{r}\right) - b_{NX} q_t + d_t \quad (2)$$

$$\pi_t = \pi_t^e + \nu\left(y_t - \acute{y}\right) + s_t \quad (3)$$

Equation (1) is a central bank's one-period loss function that penalises deviations of output and inflation from their targets; π is the targeted inflation rate announced by the central bank. Parameter Ψ is the relative weight attached by the central bank to output stabilisation. Values $\psi < 1$

$\psi < 1$ mean that the central bank is more sensitive to deviations of inflation than to output gaps; and the converse is true for values

$\psi > 1 \psi > 1$.

Equation (2) is the open economy *IS* function, presented as per cent deviation of the aggregate demand with respect to the potential output. The variable R_t stands for the real interest rate $\bar{r}$ is the marginal productivity of capital to which the real interest rate is deemed to converge in the long run. Variable q_t is the real exchange-rate (RER) gap, expressed as the difference between the (log of the) current RER and the (log of the) long-run level of this variable, which is normalised to zero. Moreover, the RER is measured as the price of the domestic output in terms or the foreign one. Consequently, q_t is expressed as: $q_t = e_t + p_t - p_t^M$, where p_t^M is the log of the world price level, e_t is the log of the nominal exchange rate – expressed as the price of the domestic currency in terms of the foreign one – and p_t is the log of the domestic price level. In the long run, the real exchange rate achieves its steady state value, which implies that $q_t = 0$.

Coefficients b_i and b_{NX} are the elasticity of domestic investment with respect to the real interest rate, and the elasticity of net exports with respect to the real exchange rate, respectively. Finally, d_t is an exogenous parameter that has two components: the first one is (the log of) the autonomous demand over the level of potential output, including the autonomous levels of private consumption and

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investment, government expenditures and net exports. The second component is a demand shock normally distributed with zero mean and variance equal to σ_d^2 . In the stationary state, it is verified that $y_t = \acute{y}$ and $d_t = 0$.

Equation (3) is the inflation-surprise aggregate supply, where parameter ν measures the sensitiveness of inflation to production pressures captured by the output gap, and s_t is a supply shock that is translated to inflation, distributed normally, $N(0, \sigma_s^2)$.

We assume that the central bank observes the occurrence of shocks and moves subsequently the nominal interest rate to minimise social losses under the restriction of the aggregate supply function (3). The solution is found by minimising social losses under the aggregate supply constraint; that is, by minimising the following Lagrangean function:

$$Min_{y,\pi} L_t = \psi (y_t - \acute{y})^2 + (\pi_t - \acute{\pi})^2 + \rho [\pi_t - \pi_t^e - \nu (y_t - \acute{y}) - s_t] \quad (4)$$

The result provides the optimal trade-off between inflation and output gaps:

$$\pi_t - \acute{\pi} = \frac{-\psi}{v} (y_t - \acute{y}) \quad (5)$$

By substituting (5) into (3), we obtain the optimal output gap:

$$(y_t - \acute{y}) = \frac{\nu}{\nu^2 + \psi} (\acute{\pi} - \pi_t^e - s_t) \quad (6)$$

Joining (6) with (3), we get:

$$\pi_t = \frac{\nu^2}{\nu^2+\psi}\acute{\pi} + \frac{\psi}{\nu^2+\psi}\pi_t^e + \frac{\psi}{\nu^2+\psi}s_t \qquad (7)$$

Equation (7) is the reaction function of the central bank that determines the optimal inflation rate for given values of π, s_t and the rate of inflation expected by private agents. Rational agents know this reaction function and use it to derive their expected rate of inflation. So, by taking rational expectations in (7), it is easy to obtain:

$$\pi_t^e = \acute{\pi} \qquad (8)$$

By substituting (8) into (6) and (7), we get:

$$(y_t - \acute{y}) = \frac{-\nu}{\nu^2+\psi}s_t \qquad (9)$$

$$\pi_t - \acute{\pi} = \frac{\psi}{\nu^2+\psi}s_t \qquad (10)$$

Equations (9) and (10) reveal that whereas inflation and output are affected by supply shocks, they are not touched by demand disturbances since the latter are instantaneously neutralised by the central bank through variations in the nominal interest rate. The optimal interest rate is, consequently, state dependent and can be derived as follows. We introduce (9) in (2) and take into account the definition of the real interest rate, $R_t = i_t - \pi$, to obtain:

$$\frac{-\nu}{\nu^2+\psi}s_t = -b_i i_t + b_i \acute{\pi} + b_i \acute{r} - b_{NX} q_t + d_t \qquad (11)$$

Observe now that the movement equation of the real exchange rate is:

$$q_t = q_{t-1} + (e_t - e_{t-1}) + \pi_t - \pi^W$$

(12)

Where π^W is the foreign rate of inflation.

We assume that, for given levels of the expected nominal exchange rate and the risk premium, the rate of nominal exchange rate variation is proportional to the gap between the domestic and foreign nominal interest rates[1]:

$$(e_t - e_{t-1}) = \lambda (i_t - i_t^W);\ \lambda > 0 \qquad (13)$$

Consequently,

$$q_t = \lambda (i_t - i_t^W) + \pi_t - \pi^W + q_{t-1} \qquad (14)$$

After introducing (14) in (11) and solving for the nominal interest rate, we get:

$$i_t = \beta d_t + \frac{\beta \nu}{\nu^2 + \psi} s_t - \beta b_{NX} \pi_t + \beta b_i \acute{\pi} + \beta b_{NX} (\lambda i_t^W + \pi^W) + \beta b_i \acute{r} - \beta b_{NX} q_{-1} \qquad (15)$$

Where $\beta = \frac{1}{b_i + \lambda b_{NX}}$

In the stationary state, the following conditions are satisfied:

1 From the uncovered interest-rate-parity (UIP) relationship, it follows that an increase in the difference between the domestic and the foreign nominal interest rate triggers capital inflows that appreciate the domestic currency sufficiently to create the expected rate of depreciation that restores UIP.

$d_t = s_t = 0 \quad , \quad \pi_t = \pi \quad , \quad q_t = 0$

By introducing these conditions in (15), it is easily verified that the nominal interest rate satisfies the Fisher condition in the stationary state:

$$i_t = \acute{r} + \pi \tag{16}$$

Since the central bank can neutralise the impact of demand shocks on output and inflation through appropriate variations in the nominal interest rate during the same period they hit the economy, demand shocks do not inflict social losses. The story is different for supply shocks, since they modify the optimal value of both output and inflation. The impact of supply shocks on social losses will last as much as the shocks, and can be calculated by substituting equations (9) and (10) into the social loss function (equation (1)).

2.2 The model under empirical rules

The assumption that all economic agents, including the central bank, behave rationally is just necessary to equip the model with theoretical consistency. We will then stick to this general condition along the whole model developed in this paper. However, given that a) knowledge is imperfect, that b) news flow to agents with lags that are uncertain in both intensity and length, and that c) many markets work inefficiently, the ability of the central bank to learn and control the economy is not as strong as assumed above. Indeed, the assumptions that central banks assess immediately the nature and size of the shocks, the value of foreign variables and the misalignment of the

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real exchange rate, and that they can implement the actions that exactly and instantaneously deliver the desired results are unsound. Those suppositions lack both realism and policy relevance. For the same token, under economic scenarios where prices adjust with important inertia, we are simply not allowed to expect that the rate of inflation will reach immediately the inflation rate targeted by the central bank. For operational reasons and policy relevance, we need to adopt alternative – and more realistic – assumptions compatible with theoretical consistency.

As far as the behaviour of the central bank is concerned, we assume that it follows the following policy rule, which is a simplified version of the Taylor's equation[2]:

$$i_t = \acute{r} + \dot{\pi} + m\left(\pi_t - \dot{\pi}\right) \tag{17}$$

where the coefficient *m* measures the aversion of the central bank to inflation. As regards this equation, two remarks are in order. First, the central bank modifies the nominal interest rate once exogenous shocks have altered the rate of inflation. It maintains the nominal interest rate out its long-term level as long as the inflation differential, $\left(\pi_t - \dot{\pi}\right)$, differs from zero. Second, the central bank is also – indirectly - concerned with the output level and consequently with economic activity, to the extent that the inflation differential is linked to the output gap through the aggregate supply function. Consequently, the parameter *m* also transmits some central bank's worry about economic activity.

As regards inflation expectations, we assume a mechanism that combines flexibly inertia with rationality. On the one hand, agents are

2 Of course, the assumption that the central bank can control the domestic nominal interest rate requires that the risk premium remains stable and/or with variations that can be neutralised by the central bank.

rational in the sense that they can calculate correctly the stationary inflation rate on the basis of the structure of the model and the information delivered by the central bank. On the other hand, they are aware that adjustments proceed with inertia, which lead them to include the inflation rate of the last year in their expectations scheme. Consequently:

$$\pi^e_{t+1}=\pi_t+\theta\left(\acute{\pi}-\pi_t\right);\ 0\leq\theta\leq 1 \tag{18}$$

where π^e_{t+1} accounts for the expected rate of inflation for period *t+1* with the information set of period *t,* and the parameter *θ* measures the speed at which the inflation rate is expected to approach its stationary level. Under zero speed, $\theta=0$, agents believe that inflation moves very slowly, and expectations just reproduce the rate of the current period $\left(\pi^e_{t+1}=\pi_t\right)$ whereas full speed, $\theta=1$, indicates the hope that the final result will be achieved during the next period $\left(\pi^e_{t+1}=\acute{\pi}\right)$. For intermediate values of parameter *θ,* expectations are determined by both the previous inflation rate (backward looking element) and the long-run inflation rate (forward looking factor).

Equation (17) can be written as follows:

$i_t-\pi^e_{t+1}=\acute{r}+\acute{\pi}+m\left(\pi_t-\acute{\pi}\right)-\pi^e_{t+1}$; that is:

$$R_t=\acute{r}+\acute{\pi}+m\left(\pi_t-\acute{\pi}\right)-\pi^e_{t+1} \tag{19}$$

By inserting (14) in (15), we obtain the monetary policy rule in terms of the real interest rate:

$$R_t=\acute{r}+\left(m+\theta-1\right)\left(\pi_t-\acute{\pi}\right) \tag{20}$$

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The aggregate demand (AD) schedule

Introducing (20) in (2), we obtain:

$$y_t - \acute{y} = -b_i(m + \theta - 1)(\pi_t - \acute{\pi}) - b_{NX} q_t + d_t \tag{21}$$

Joining (14) with (17), it is easy re reach:

$$q_t = q_{t-1} + (1 + \lambda m)(\pi_t - \pi^W) - \delta \tag{22}$$

Where, $\delta = \pi^W + \lambda(i^W - \acute{r}) - (1 + \lambda)\acute{\pi}$

Finally, substituting (22) into (21), we get:

$$y_t - \acute{y} = \delta b_{NX} - \acute{b}(\pi_t - \acute{\pi}) - b_{NX} q_{t-1} + d_t$$

(23)

$$\acute{b} = b_i(m + \theta - 1) + b_{NX}(1 + \lambda m)$$

Equation (23) is the aggregate demand (AD) schedule, with a negative slope in the space (*π, y*).

The aggregate supply (AS) schedule

We obtain the aggregate supply in the space (*π, y*) by combining the expectations mechanism (14), which provides the equation for π_t^e, with equation (3):

$$\pi_t - \acute{\pi} = (1 - \theta)\pi_{t-1} + \nu(y_t - \acute{y}) + (\theta - 1)\acute{\pi} + s_t \tag{24}$$

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The complete AD/AS model

The whole model is composed of the following equations:

AD: $$y_t - \acute{y} = \delta b_{NX} - \acute{b}(\pi_t - \dot{\pi}) - b_{NX} q_{t-1} + d_t \quad (23)$$

AS: $$\pi_t - \dot{\pi} = (1-\theta)\pi_{t-1} + \nu(y_t - \acute{y}) + (\theta - 1)\dot{\pi} + s_t \quad (24)$$

Dynamics of the RER: $$q_t = q_{t-1} + (1+\lambda m)(\pi_t - \pi^W) - \delta \quad (22)$$

$$\acute{b} = b_i(m+\theta-1) + b_{NX}(1+\lambda m)$$

$$\delta = \pi^W + \lambda(i^W - \acute{r}) - (1+\lambda)\acute{\pi}$$

The Appendix to this paper explains the solution of the model and derives the stability conditions. In the next section, we introduce the equilibrium equations for the rate of inflation and the output gap in the social losses function to compute, alternatively, the optimal values of parameters θ and *m*.

3. Simulation and computation of social losses

Let us now simulate the impacts generated by external shocks. We analyse subsequently the effects of a permanent demand shock and of a transitory supply shock. For this purpose, we give the main parameters reasonable numerical values for this type of aggregate models:

$\acute{y}=1$; $\pi=0.02$; $\nu=0,2$; $b_{NX}=0.6$; $b_i=1$; $\lambda=3$, and $m=2$.

3.1 An expansionary permanent demand shock

Let us assume that the economy suffers a permanent demand shock, $d=0,1$, starting at the stationary state[3]; that is, with $y_0=\acute{y}$, $\pi_0=\pi$ and $q_0=0$.

3.1.1 Simulations with different values of the parameter θ

In the following graphs we show several simulations for different speeds at which agents hope that the rate of inflation will converge to the inflation rate targeted by the central bank. Figures 1, 2 and 3 show the time paths of domestic output, the inflation rate and the real exchange rate, respectively. Each figure includes four simulations obtained with four different speeds: two extreme values, $\theta=0$ and $\theta=1$, embedded in simulations 1 and 4, and two intermediate values, ($\theta=0,3$; $\theta=0,7$), included in simulations 2 and 3.

Figure 3: Output Gap after a permanent Demand Shock

3 Demand shocks have been predominant in industrial economies along the last decades and, according to García-Solanes, Rodríguez-López and Torres (2011), they explain most of the variability of trade imbalances of those countries.

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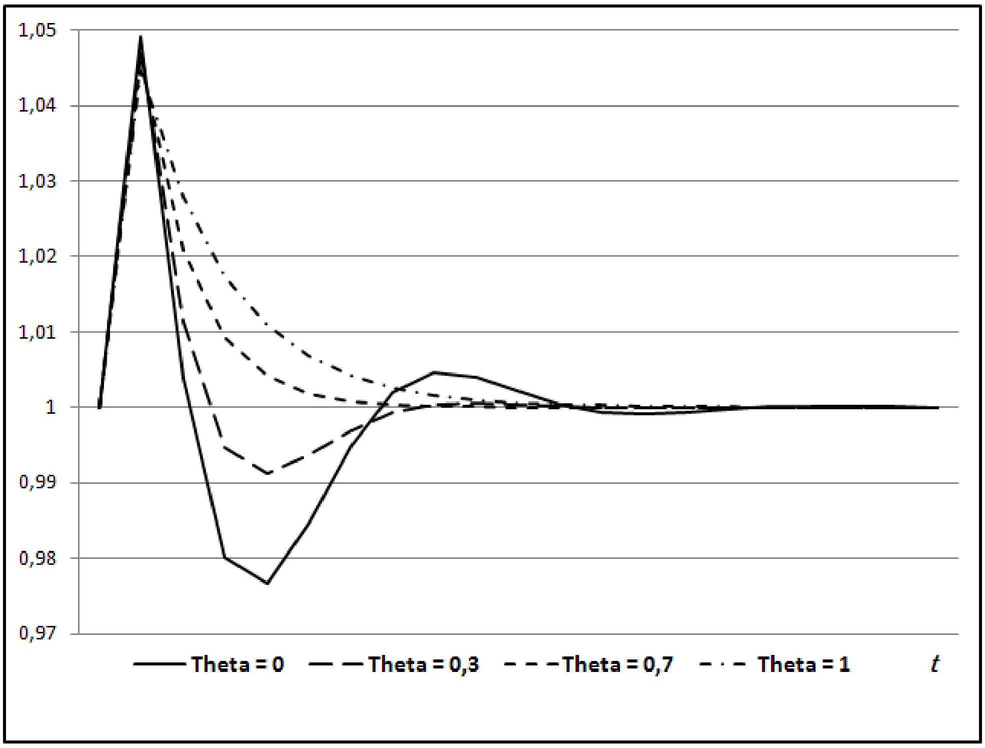

Figure 4: Inflation Rate after a Permanent Demand Shock

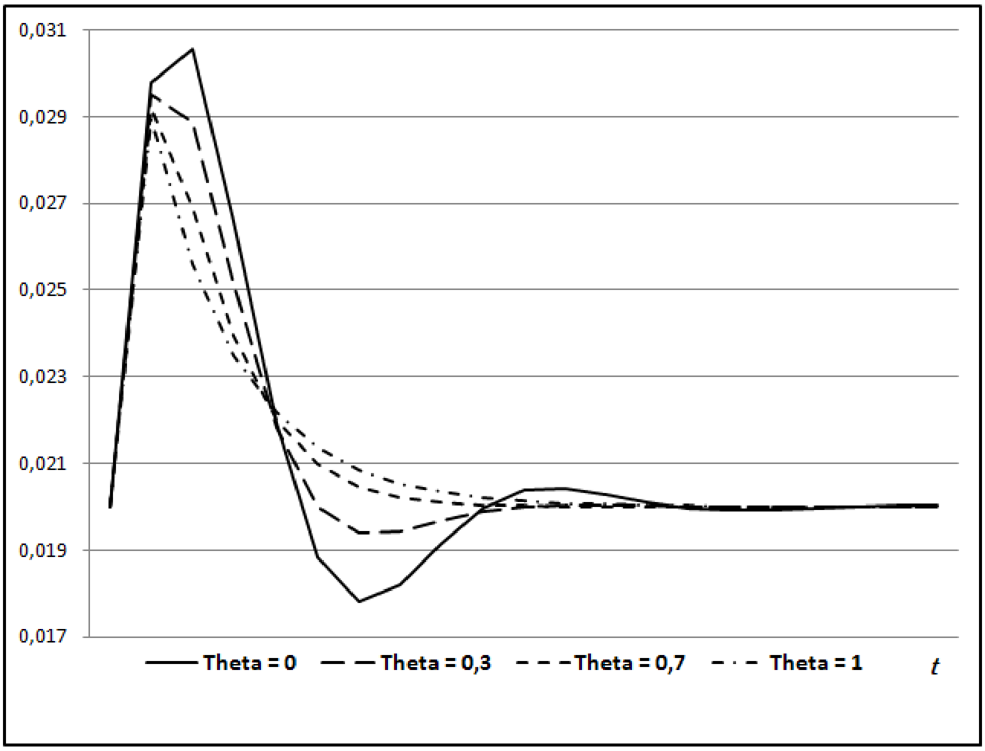

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Figure 5: Real Exchange Rate after a permanent Demand Shock

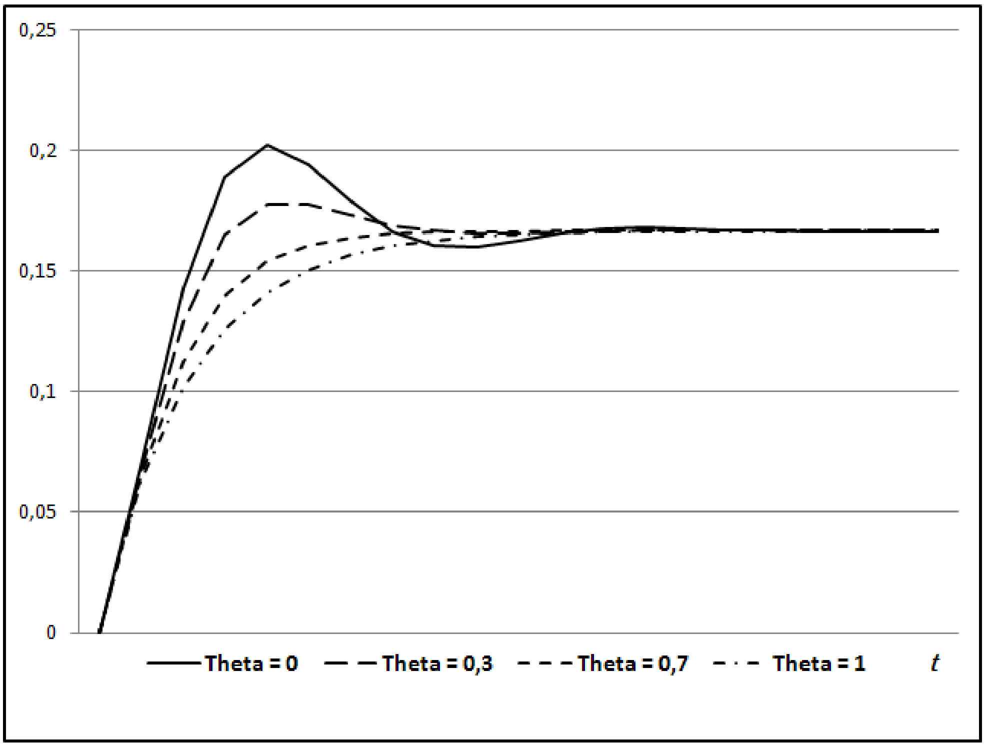


Figure 1 depicts the adjustment of domestic output. The demand shock does not alter the long run equilibrium of this variable, but the mechanism of inflation expectations modifies sensibly the adjustment trajectories. Under the simple adaptive scheme, $\pi_t^e = \pi_{t-1}$, embodied in simulation 1, the time path draws increasingly mitigated oscillations around the long-run equilibrium level. Once we enlarge the expectations mechanism by including increasing values of parameter θ , oscillations dampen and the time path of output evolves towards hyperbole curves.

Figure 2 draws four time paths of the rate of inflation depending on the values accorded to parameter θ . Simulations show results in line with those depicted for domestic output. The long run equilibrium is completely determined by the central bank target – i.e. it is not affected by the demand shock – but the time trajectories are very sensitive to the values of θ . Again, oscillations mitigate as the value of θ increases, and turn into hyperbole curves for values of θ over a certain threshold.

Figure 3 depicts the four dynamic adjustments corresponding to the RER. The trajectories are sensitive to changes in the parameter θ in a similar way as for output and inflation. For $\theta=0$ the RER overshoots its long-run level during the first periods after the shock. However, it always converges towards an appreciated long-run level. The reason is that the RER must appreciate to crowd out the initial permanent expansion in the aggregate demand.

Figure 4 draws the time paths of the pair output-inflation for the four assumed values of the parameter θ . The extreme case of adaptive expectations, $\pi_t^e=\pi_{t-1}$, generates a spiral trajectory. The opposite extreme, $\pi_t^e=\acute{\pi}$, creates the path captured by the straight line. Finally, the two intermediate cases give rise to curve trajectories which convexity decreases with parameter θ .

Finally, figures 5 draw the social losses created by the demand shock for the four speeds of inflation adjustment considered in this empirical analysis. It is verified that the trajectories and the total amount of social losses are sensitive to the speed of inflation adjustment. Within the range of continuum values of parameter θ , the one that minimises the total amount of social losses is $\theta=0.52$

Figure 6: Equilibrium Dynamics after e permanent Demand Shock

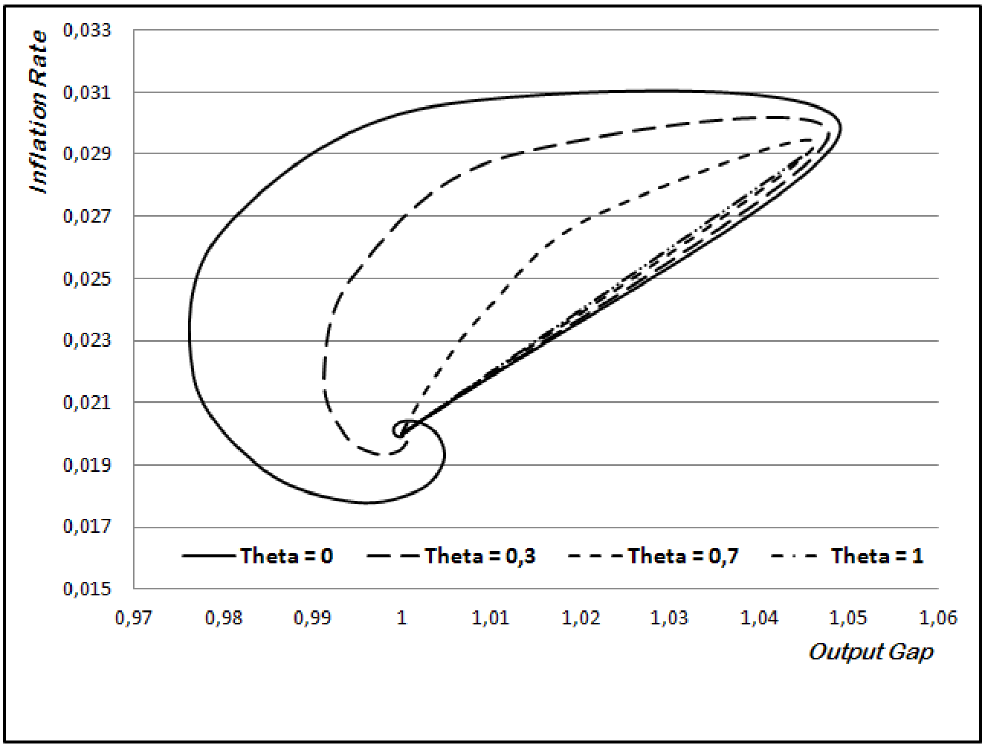


Figure 7: Social Losses after a permanent Demand Shock (Psi = 0,25)

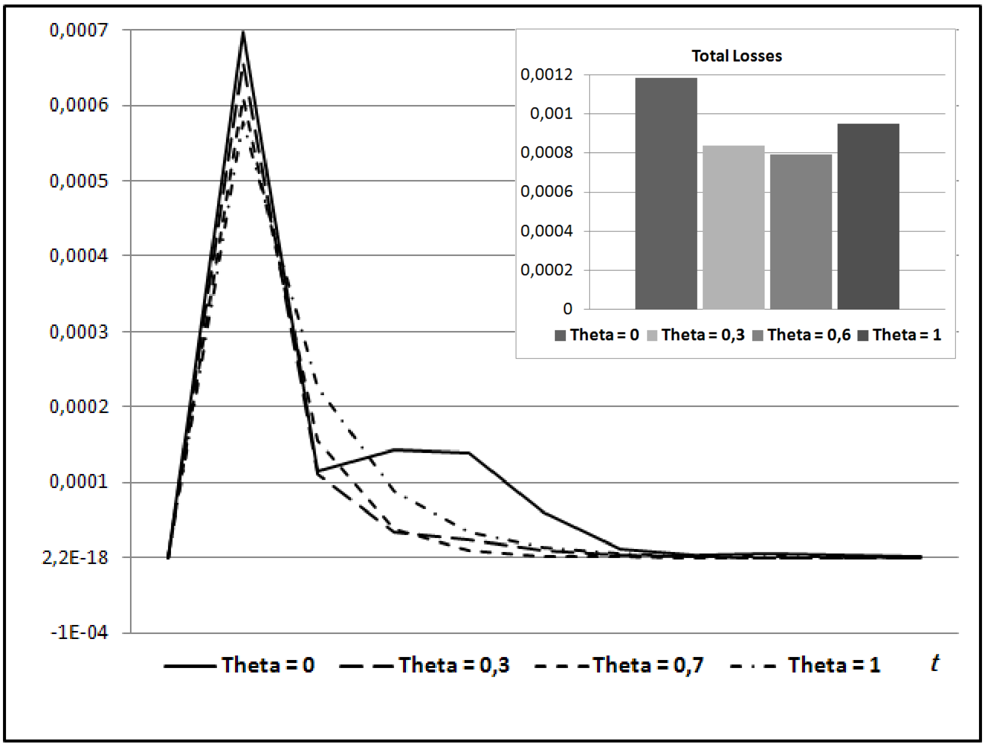
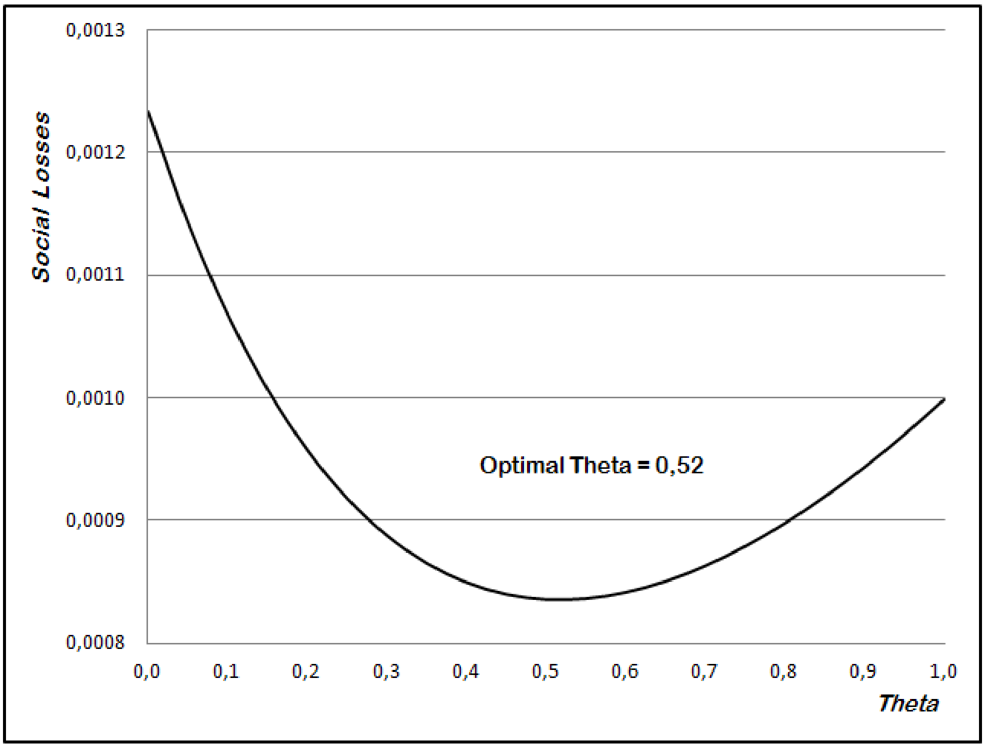


Figure 8: Social Losses after a permanent Demand Shock (Psi = 0,25)



3.1.2 Simulations with different values of the parameter m

We perform now simulations to compute the optimal value of the sensitivity of the central bank to inflation variability. We assume that agents adapt the value of parameter θ taking into account recent past deviations of the rate of inflation with respect to the inflation target:

$$\theta_t = 1 - \alpha\left[\left|\pi_{t-3} - \acute{\pi}\right| + \left|\pi_{t-2} - \acute{\pi}\right| + \left|\pi_{t-1} - \acute{\pi}\right|\right]\frac{1}{3}100$$

Figures 7, 8 and 9 show the paths of the output gap, the rate of inflation and the real exchange rate for four alternative values of *m*. It is apparent that the volatility of the three endogenous variables decreases with *m*. Consequently, social losses should decrease as the aggressively of the central bank increases. Figure 10, where the evolution of total social losses for each value of *m* is represented, confirms this result.

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Figure 9: Output Gap Dynamics for alternative values of *m*

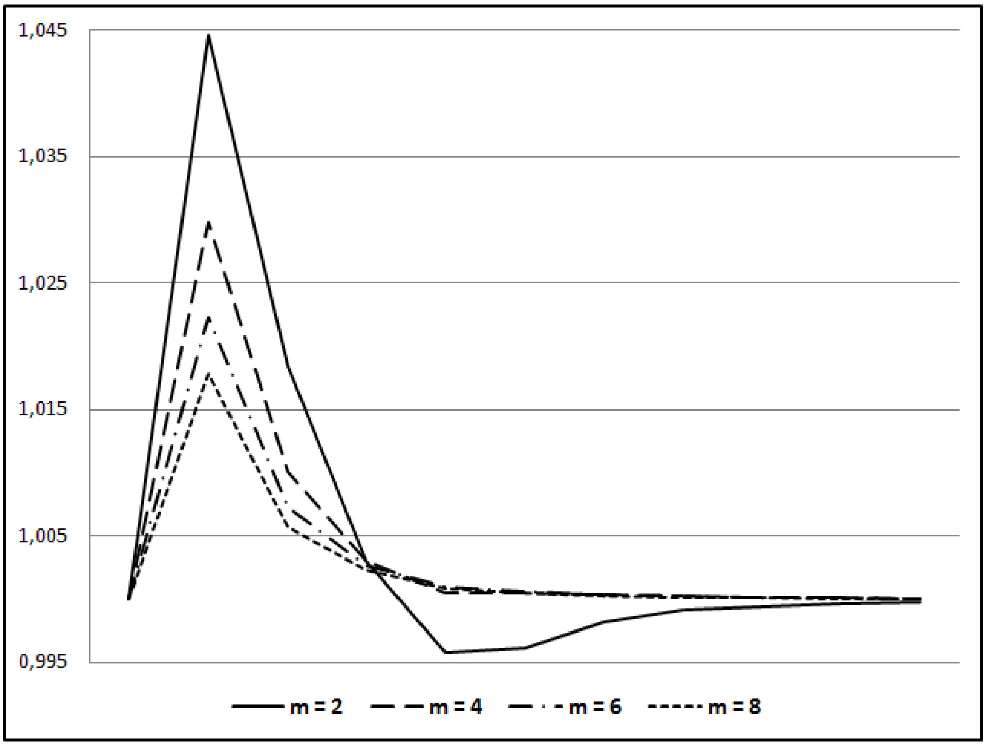

Figure 10: Inflation Dynamics for different values of *m*

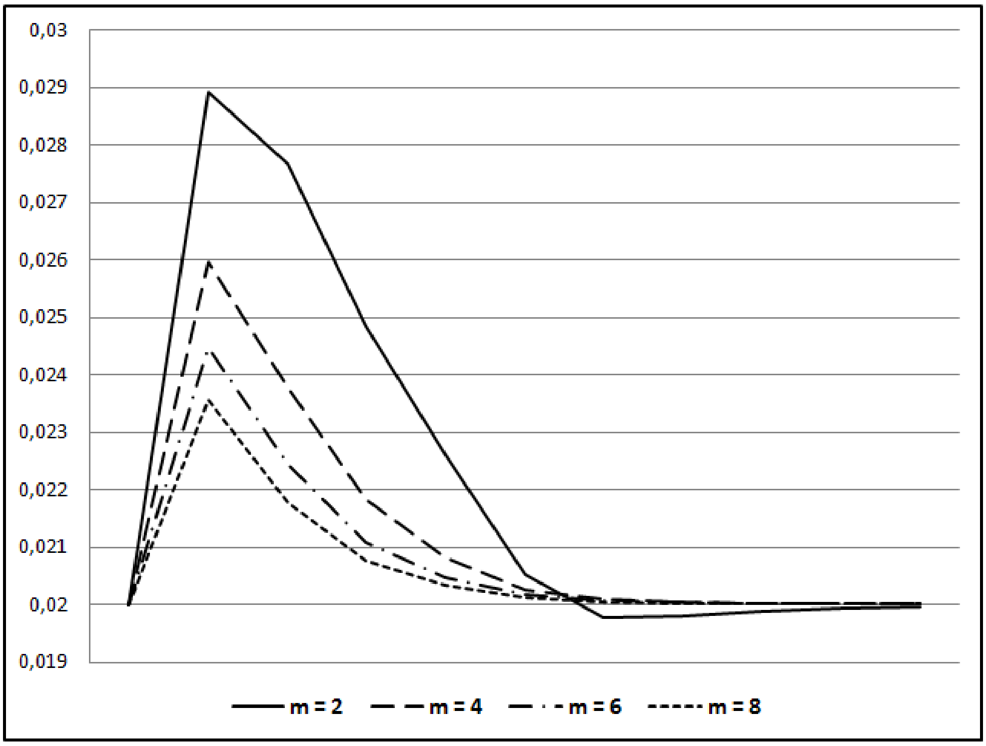

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Figure 11: Real Exchange Rate Dynamics for different values of *m*

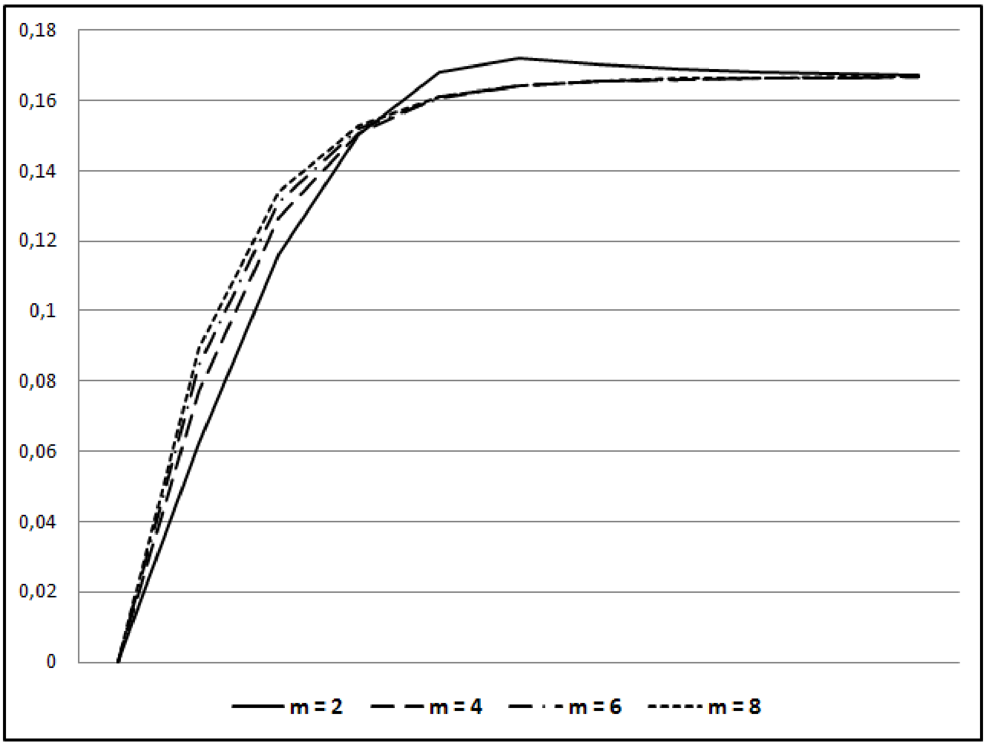
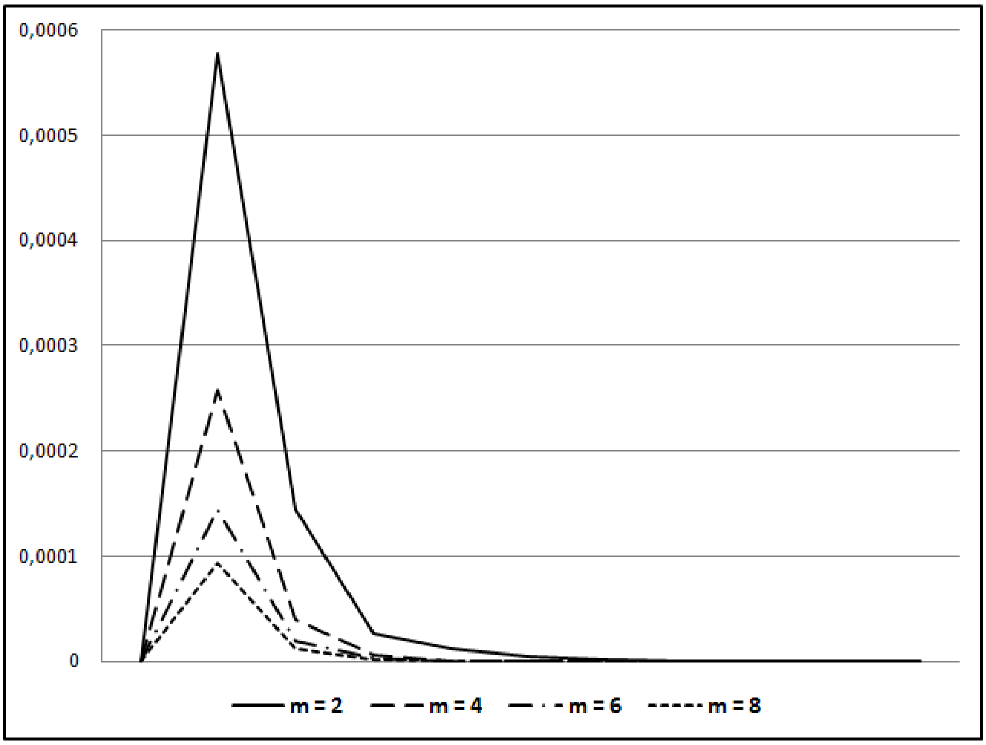


Figure 12: Social Losses for different values of *m*



At a first sight, the central bank should implement a monetary policy as aggressive against inflation as possible. This would be, however, a misleading advice since increasing degrees of anti-inflation sensitiveness feds the volatility of the interest rate, which is not good for the economy. Figure 10 provides evidence of this result: the volatility of the nominal interest rate, measured with the standard deviation of this variable during the whole transition period, is an increasing function of the four discrete values of the parameter *m* used in the simulations. Figure 11, shows the evolution of both, social losses and interest-rate volatility, when the monetary policy parameter changes in continuous time. The two trajectories exhibit asymmetric slopes, with increasing divergence as the monetary policy parameter goes up.

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Figure 13: Interest Rate Volatility for different values of *m*

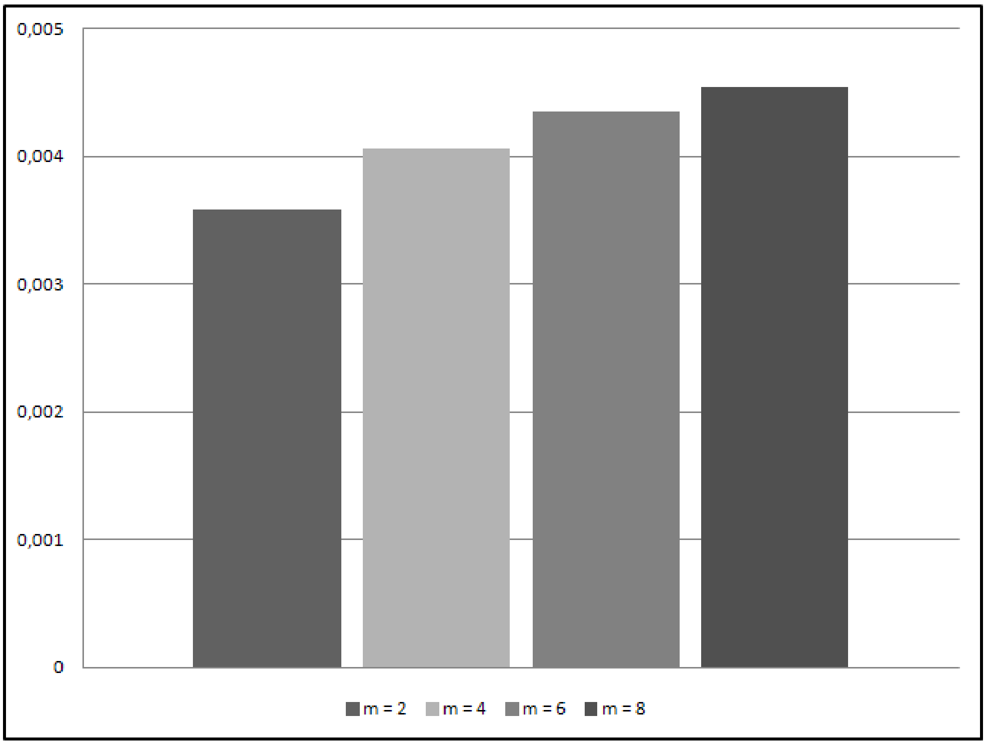
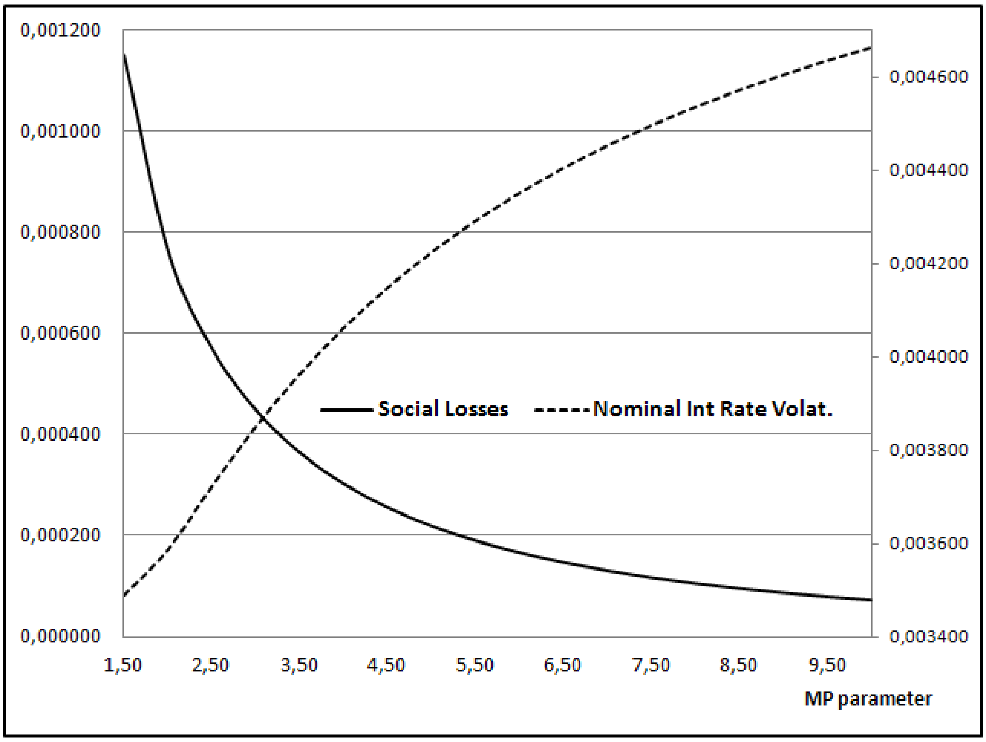


Figure 14: Monetary Policy trade-off



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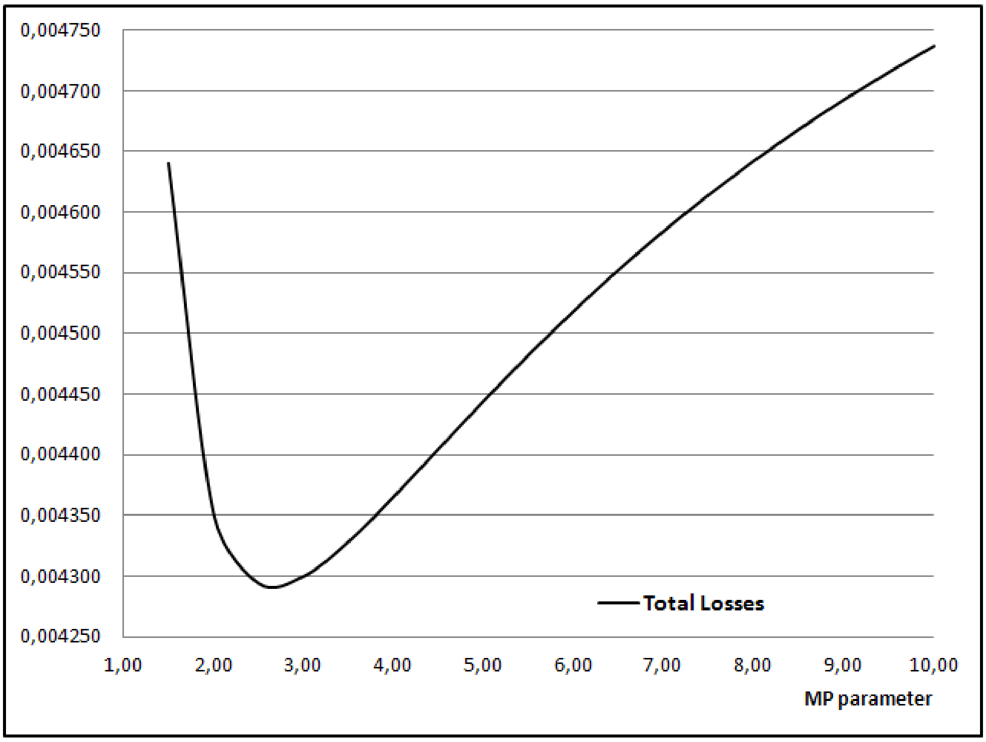
Interest rate volatility affects negatively social welfare through its impact on asset valuations, commodity prices, credit, leverage, etc. For this reason, we opted for including the volatility of the interest rate in the social losses function, assuming that it affects social losses with a positive sign, in accordance with the procedure suggested by Eichengreen et al. (2011), Orphanides (2001) and Natraj (2013), among others. We computed the composed social losses as a continuous function of the monetary policy parameter. The result is presented graphically in Figure 12.

Figure 15: Optimal Monetary Policy



The monetary policy parameter that minimises the composed social losses is 2.7.

4.2 An inflation-augmenting transitory supply shock

4.2.1 Simulations with different values of the parameter θ

Assume now that, starting at the stationary state, the economy is hit by an inflation augmenting supply shock, $s=0.1$. Figures 13, 14 and 15 trace the time trajectories of the three main endogenous variables, output gap, inflation and the RER, respectively. As far as the output gap is concerned, Figure 13 shows that this variable is affected very negatively during the first period, and that it reaches rapidly the stationary state value once the shock has disappeared. For small values of *θ,* the output gap overshoots its long-run level during some post shock periods.

As regards the inflation rate, Figure 14 shows that inflation increases sharply during the first period, and that it falls down abruptly once the shock disappears. The inflation rate oscillates around the long-run level during some periods after the shock – with important initial undershooting -, but swings dampen as parameter *θ* goes up.

The dynamics of the real exchange rate is shown in Figure 15. As can be seen, the RER exhibits similar trajectories as those of the inflation rate, but with more dampened swings. Moreover, undershooting during some post shock periods takes place only for *θ=0.*

Figure 16: Output Gap after a transitory Supply Shock

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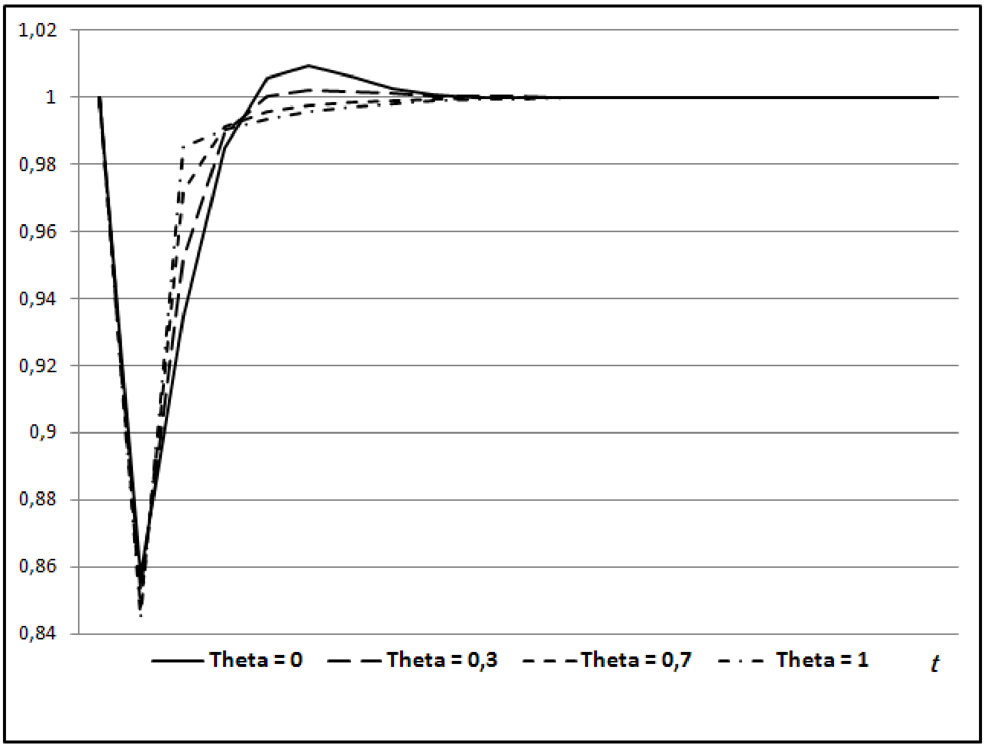
1,02
1
0,98
0,96
0,94
0,92
0,9
0,88
0,86
0,84
Theta = 0
Theta = 0,3
Theta = 0,7
Theta = 1
t

27

Figure 17: Inflation Rate after a transitory Supply Shock

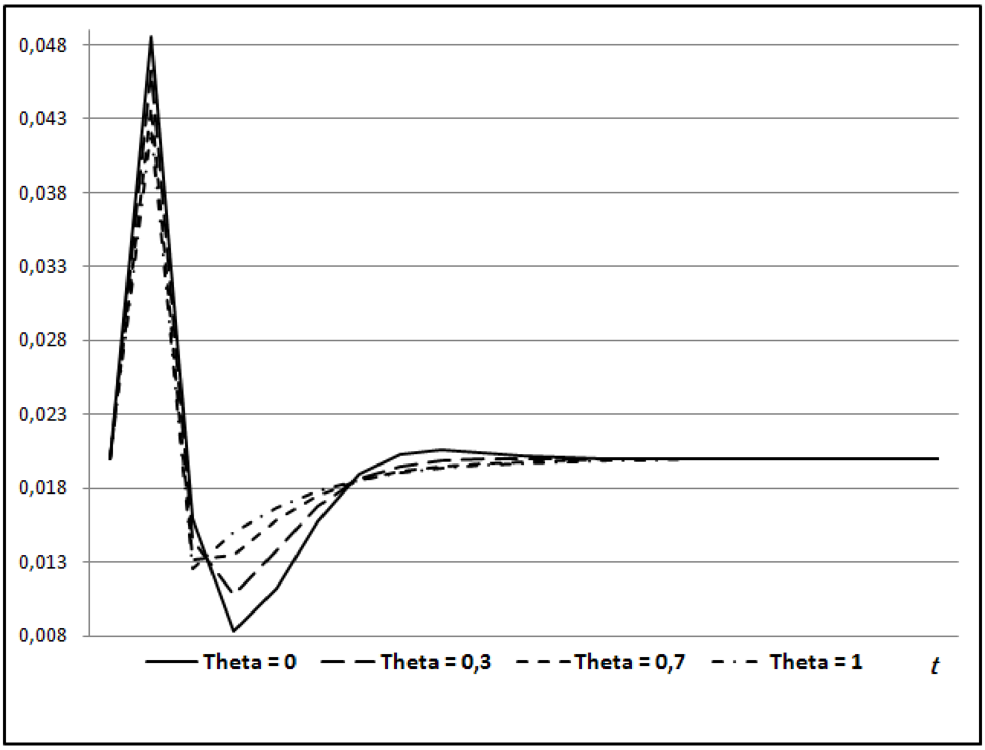

Figure 18: Real Exchange Rate after a transitory Supply Shock

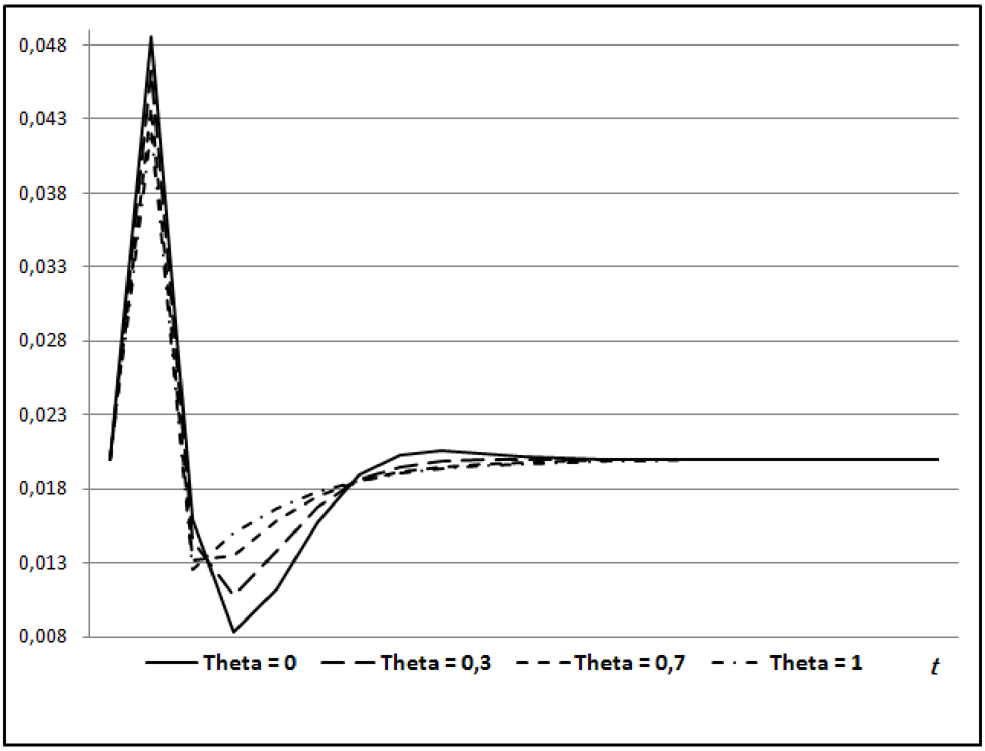

Figure 16 depicts the equilibrium dynamics of the output gap and the inflation rate, in the space (π, y), for each of the four selected values of parameter θ. It is apparent that oscillations of the output gap increase and those of the inflation rate decrease as parameter θ goes up.

Finally, Figure 17 shows the time trajectory of social losses and the amount of total losses incurred during the adjustment periods, for different values of parameter θ. Our computations indicate that, among the values of parameter θ considered in this study, the minimum level of total losses is obtained for θ=064. From the dynamic equation that provides the expectations mechanism, the value θ= 0.64 implies that the transit of inflation towards its long-run level after the initial shot induced by the shock– for instance, the inflation rate reaches π = 0.49 in the first period after the supply shock – lasts between 4 and 6 years[4]. Consequently it is optimal for the central bank to publicly announce that, once the economy is hit by an external shock, it will take between 4 and 6 years for the inflation rate to come back very closely to its targeted value.

Figure 19: Equilibrium Dynamics after a transitory Supply Shock

4 The inflation rate reaches 0.24 after four periods and 0.22 after six periods.

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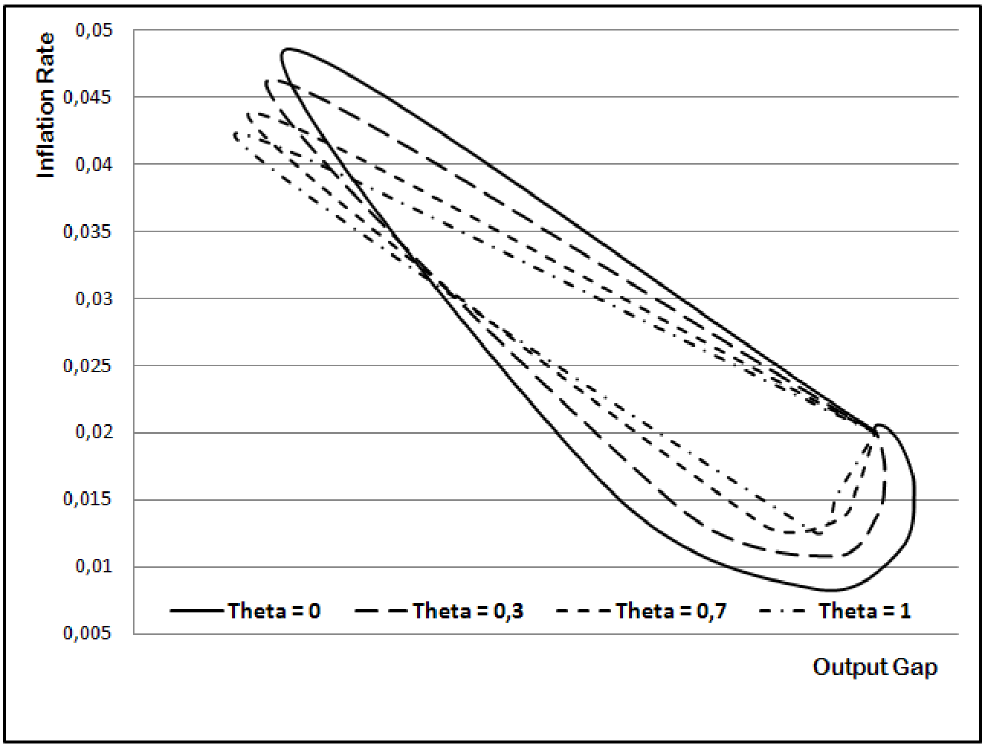

Figure 20: Social Losses after a transitory Supply Shock (Psi = 0,25)

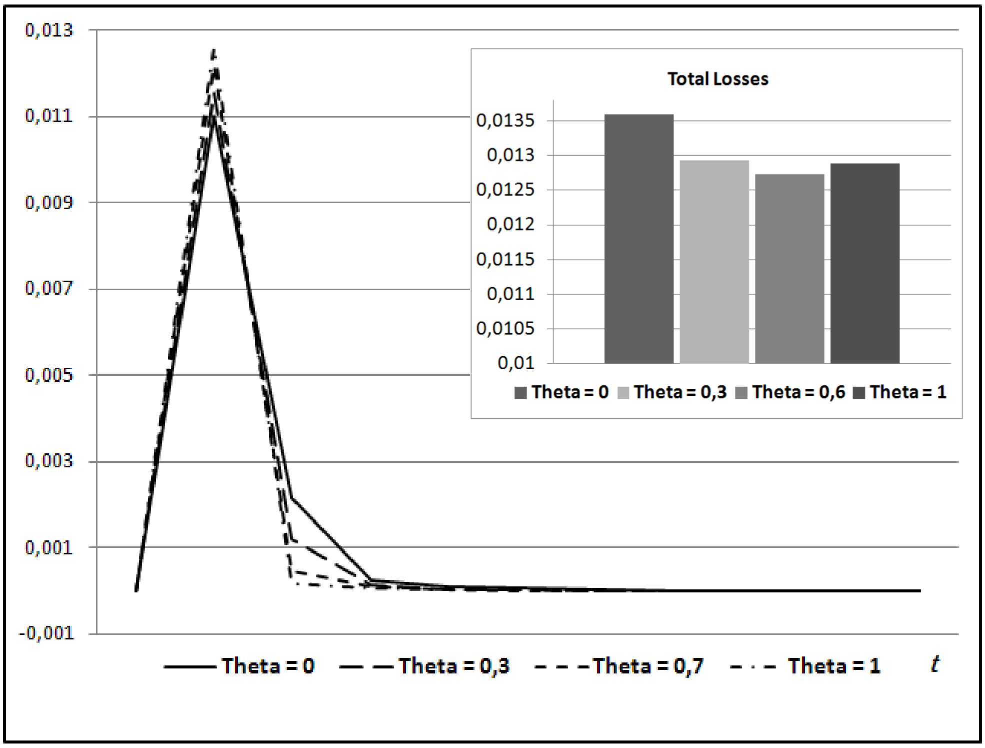

Figure 21: Total Social Losses after a permanent Demand Shock

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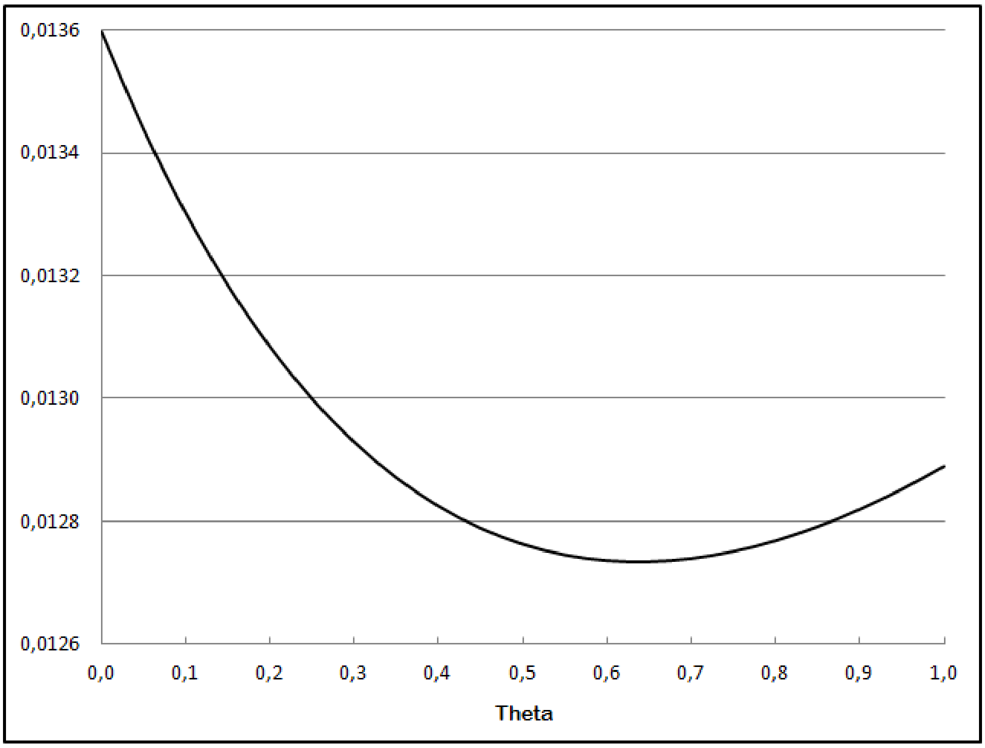

Figure 18 presents the social losses when paramenter θ varies in continuous time. The value of parameter θ that minimises total social losses is 0.64.

4.2.2 Simulations with different values of the parameter *m*

Simulations of the model for different values of parameter *m* provide time paths of the endogenous variables provide similar trajectories to those of the preceding graphs, but with increasingly widened fluctuationsa as monetary policy becomes morea ggressive. For reasons of space we do not provide those simulations and limit ourselfs to the computation of social losses.

For the same reasons argued in section 4.1.2 we compute the varaibility of the interest rate as a function of the paramenter *m*. Figure 19 illustrates the fact that both social losses and volatility in the interest rate increase gradually as monetary policy becomes more aggressive. The direct implication is that the value of *m* should be brought to zero, which means that the central bank should give up the inflation targeting scheme as a

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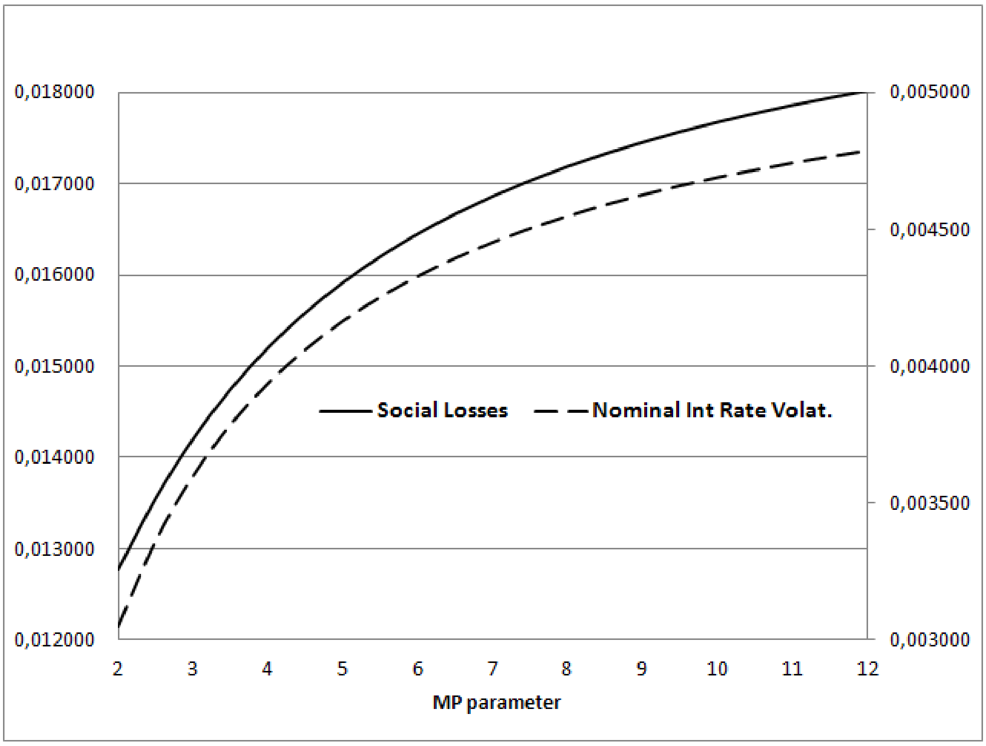
general approach to monetary policy.

Figure: 22: Monetary Policy Trade-off



This conclusion is not surprising when the weight of output variability in the loss function overcomes certain threshold. The reason, outlined by Frankel (2003), is that the inflation targeting regime may not give appropriate response to terms-of-trade shocks in countries where reductions in output are convulsive for the economy, as in the case of most emerging market economies. As can be seen in Figure 13, an adverse supply shock makes the output gap to decline sharply, whereas the appreciation of the real exchange rate is exacerbated by an appreciating reaction of the nominal exchange rate. This result leads us to suspect that the only possibility for the inflation targeting to become a useful device under the scenario of supply shocks, must be found in cases where variations of output are granted a very low weight in the loss function. To verify this suspicion, we performed simulations for very low values of the parameter ψ. The results for $\psi = 0.1$ are portrayed in figure 20.

Figure 23: Monetary Policy Trade-off

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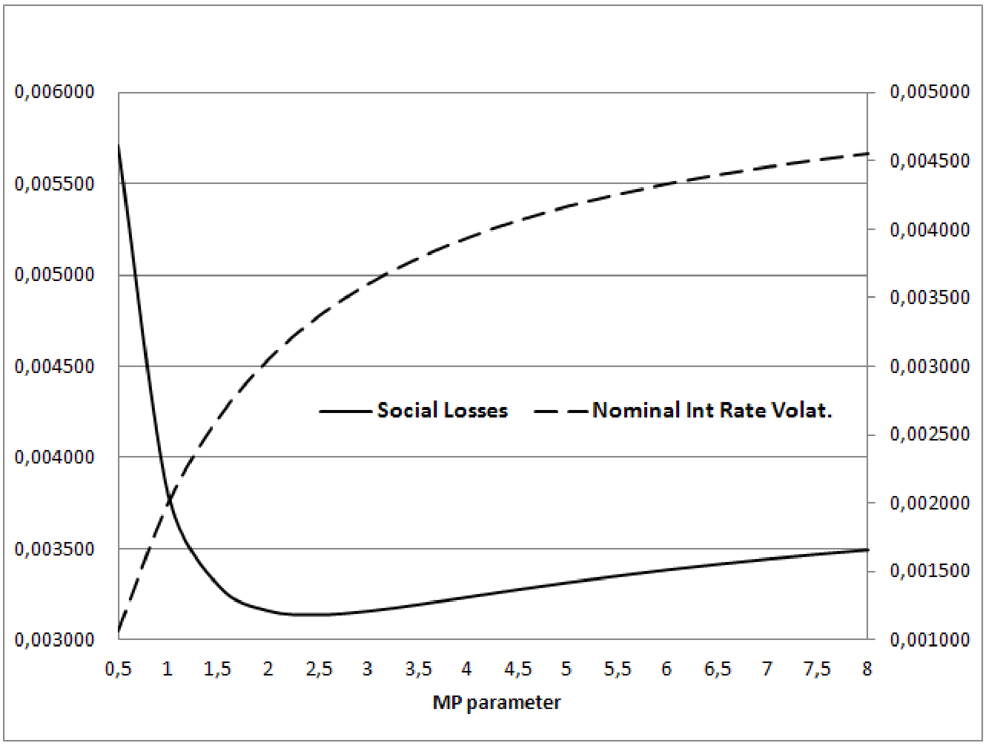
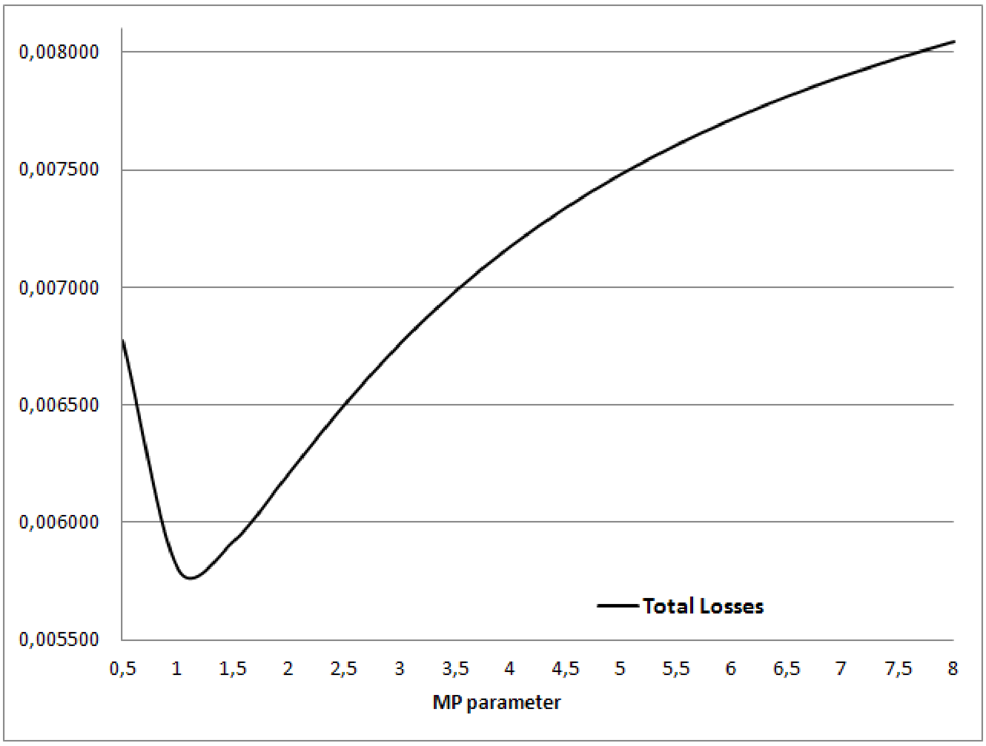


It is apparent now that social losses and nominal interest volatility exhibit opposite trajectories that cross themselves at a small value of the parameter *m*. This implies that there is a particular value of this parameter that minimises composed social losses, which is determined and drawn in Figure 21. The optimal value of *m* is 1.11.

Figure 24: Optimal Monetary Policy



It can be easily shown that an increase in financial instability, which implies higher interest rate volatility, decreases the optimal value of the monetary policy parameter because it moves the interest-rate volatility curve upwards en figures 11 and 20. Moreover, an increase in the weight granted to financial volatility en the loss function shifts the turning point of the compounded loss function to the left in figures 12 and 22, impacting downwards as well on the optimal value of parameter *m*. It turns out, then, that the two preceding circumstances contribute to diminish the activity of central banks that follow an inflation targeting regime.

4. Concluding remarks

In this paper we have built an open macroeconomic model to investigate the dynamic adjustment of output, inflation and the real exchange rate, and the induced effects on social losses, after exogenous shocks from the demand and supply sides of the economy. We solved and simulated the model to assess the role of both the inflation expectations mechanism and the monetary rules in the dynamic adjustments triggered, alternatively, by permanent demand shocks and transitory supply disturbances. Under the

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scenario in which the central bank and private agents follow consistent empirical rules, the time paths of the three endogenous variables are very sensitive to the speed of inflation adjustment (θ) and to the monetary policy parameter (*m*).

The model opens two alternative options for the central banks. The first one consists of deriving the optimal speed of inflation adjustment (the one that minimise social losses), for a given value of the parameter *m*, and to publicize it in order to shape the expectations mechanism used by the market participants. This information is all of a piece of the multi-year inflation target announce. The optimal θ is dependent on the type of shock that hits the economy. The second option consists of computing the optimal monetary policy stance taking into account the inflation expectations mechanism - which in our model follows an adaptive scheme - the nature of shocks, and the impinged effects on interest rate variability. It turns out that the inclusion of interest rate variability in the loss function is essential to make operative the monetary policy rule under permanent demand shocks, and reinforces the suggestion of Eichengreen, Prasad and Rajan (2011) that financial stability should be an explicit mandate of central banks in the current period of financial instability.

We found two important results concerning the validity and applicability of the inflation targeting approach to monetary policy. The first one is that variability in interest rates, which is linked to financial instability, and/or the weight with which it enters the social loss function, reduce the value of *m,* that is, they curtail the monetary aggressiveness of the central bank. In order to justify their reduced activism in periods of financial stress, the central banks need to explain how they seek to balance the three objectives: price stability, low output variability, and financial stability. The second result is that supply shocks undermine seriously the stabilising properties of the inflation targeting regime. The reason is that this scheme of monetary policy magnifies the fluctuations of output by letting the nominal and real exchange rates to appreciate considerably after supply shocks[5]. We show that, under those circumstances, viability of the IT regime

5 In fact, in that case output stabilization would require depreciating the nominal and real exchange rates, as stressed by Frankel (2003).

is only possible when output variability is granted very low weights in the social loss function.

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APPENDIX

The whole model is composed of the following equations:

AD: $$y_t-\bar{y}=\delta\, b_{NX}-\bar{b}\left(\pi_t-\bar{\pi}\right)-b_{NX}\, q_{t-1}+d_t \quad \text{(A1)}$$

AS: $$\pi_t-\bar{\pi}=\left(1-\theta\right)\left(\pi_{t-1}-\bar{\pi}\right)+\nu\left(y_t-\bar{y}\right)+s_t \quad \text{(A2)}$$

Dynamics of the RER: $$q_t=q_{t-1}+\left(1+\lambda m\right)\left(\pi_t-\bar{\pi}\right)-\delta \quad \text{(A3)}$$

$$\bar{b}=b_i\left(m+\theta-1\right)+b_{NX}\left(1+\lambda m\right) \quad \text{(A4)}$$

$$\delta=\pi^M-\bar{\pi}+\lambda\left(i^M-\bar{r}-\bar{\pi}\right) \quad \text{(A5)}$$

Solving for the endogenous variables of the system:

$$\left(y_t-\bar{y}\right)=\frac{\delta\, b_{NX}+d_t-\bar{b}\, s_t}{1+\bar{b}\,\nu}-\frac{\bar{b}\left(1-\theta\right)}{1+\bar{b}\,\nu}\left(\pi_{t-1}-\bar{\pi}\right)-\frac{b_{NX}}{1+\bar{b}\,\nu}\, q_{t-1} \quad \text{(A6)}$$

$$\left(\pi_t-\bar{\pi}\right)=\frac{\nu\,\delta\, b_{NX}+\nu\, d_t+s_t}{1+\bar{b}\,\nu}+\frac{1}{1+\bar{b}\,\nu}\left(1-\theta\right)\left(\pi_{t-1}-\bar{\pi}\right)-\frac{\nu\, b_{NX}}{1+\bar{b}\,\nu}\, q_{t-1} \quad \text{(A7)}$$

$$q_t=q_{t-1}+\left(1+\lambda m\right)\left(\pi_t-\bar{\pi}\right)-\delta \quad \text{(A8)}$$

In the steady state: $y_t=y^*$, $\pi_t=\pi^*$ and $q_t=q^*$. Moreover, given that in the long run the Fisher effect and the law of one price are both satisfied, from (A5) it easy to verify that: $\delta=0$. Consequently,

$$\left(y^*-\bar{y}\right)=\frac{-s_t}{\nu} \quad \text{(A9)}$$

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$$q^{¿}=\frac{\nu\, d_t+s_t}{\nu\, b_{NX}} \qquad (A10)$$

$$\pi^{¿}=\acute{\pi} \qquad (A11)$$

To analyze the dynamic stability of the model, from (A7) and (A8) the underlying system of dynamic equations is derived:

$$\Delta\pi_t=\alpha_\pi-\frac{\theta+\acute{b}\,\nu}{1+\acute{b}\,\nu}\pi_{t-1}-\frac{\nu\, b_{NX}}{1+\acute{b}\,\nu}q_{t-1} \qquad (A12)$$

$$\Delta q_t=\alpha_q+\frac{1+\lambda m}{1+\acute{b}\,\nu}(1-\theta)\pi_{t-1}-\frac{\nu\, b_{NX}(1+\lambda m)}{1+\acute{b}\,\nu}q_{t-1} \qquad (A13)$$

$$\alpha_\pi=\frac{\nu\,\delta\, b_{NX}+\nu\, d_t+s_t+(\theta+\acute{b}\,\nu)\acute{\pi}}{1+\acute{b}\,\nu} \qquad (A14)$$

$$\alpha_q=\frac{(1+\lambda m)\left[\nu\,\delta\, b_{NX}+\nu\, d_t+s_t-(1-\theta)\acute{\pi}\right]}{1+\acute{b}\,\nu} \qquad (A15)$$

So the matrix structure of the first order Taylor expansion around the steady state is:

$$\begin{pmatrix}\Delta\pi\\ \Delta q\end{pmatrix}=\begin{pmatrix}\frac{-\theta+\acute{b}\,\nu}{1+\acute{b}\,\nu} & \frac{-\nu\, b_{NX}}{1+\acute{b}\,\nu}\\ \frac{1+\lambda m}{1+\acute{b}\,\nu}(1-\theta) & \frac{-\nu\, b_{NX}(1+\lambda m)}{1+\acute{b}\,\nu}\end{pmatrix}\begin{pmatrix}\pi-\pi^{¿}\\ q-q^{¿}\end{pmatrix} \qquad (A16)$$

Named A the two by two previous matrix, we derive its characteristic equation so that $det(A-\xi I)=0.$ $det(A-\xi\, I)=0\,.$

$$det\begin{pmatrix} \frac{-\theta+\acute{b}\nu}{1+\acute{b}\nu}-\xi & \frac{-\nu b_{NX}}{1+\acute{b}\nu} \\ \frac{1+\lambda m}{1+\acute{b}\nu}(1-\theta) & \frac{-\nu b_{NX}(1+\lambda m)}{1+\acute{b}\nu}-\xi \end{pmatrix}=0 \qquad \text{(A17)}$$

Solving the previous determinant we get the characteristic equation (A18).

$$(1+\acute{b}\nu)\xi^2+[\nu b_{NX}(1+\lambda m)+(\theta+\acute{b}\nu)]\xi+\nu b_{NX}(1+\lambda m)=0 \qquad \text{(A18)}$$

That equation (A18) has all coefficients positive guarantees negative eigenvalues and consequently the stability of the system.

References

Carlin, W. and D. Soskice (2010), “A New Keynesian Open Economy Model for Policy Analysis”, CEPR Discussion paper series , Nº 7979.

Clarida, R., Gali, J. and M. Gertler (2001), “Optimal monetary policy in open versus closed economies: an integrated approach”, *American Economic Review Papers and Proceedings*, 91(2): 248-252.

Eichengreen, B., Prasad, E., and R. Raghuram (2011), “Rethinking central banking”, *VoxEU.org,* 20 September 2011.

Frankel, J. A. (2003), “Experience of and lessons from exchange rate regimes in emerging economies”, NBER Working Paper 10032.

Gali, J. (2008): *Monetary Policy, Inflation and the Business Cycle*, Princeton University Press.

Gali, J. and T. Monacelli (2005), “Monetary policy and exchange rate volatility in a small open economy”, *Review of Economic Studies* 72: 707-734.

39

García-Solanes, J., Rodríguez-López, J. and J.L. Torres (2011), "Demand Shocks and Trade Balance Dynamics", *Open Economic Review* 22: 739-766.

Levin, J. (2004), "A model of Inflation Targeting in an Open Economy", *International of Finance and Economics,* 9: 347-362.

Natraj, Ganesh, Viswanath (2013), "Is the RBA Averse to Interest Rate Volatility?, mimeo, UWA Business School.

Neuenkirch, M. and P. Tillmann (2012), "Inflationn Targeting, Credibility and Non-Linear Taylor Rules", MAGKS Joint Discussion Paper Series in Economics, N0. 35-2012.

Orphanides, A. (2001), "Monetary policy rules based on real-time data", *American Economic Review*, 91 (4), 964-985.

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